Research Note RM-458

October 1985

USDA Forest Service
Rocky Mountain Forest and
Range Experiment Station

Effectiveness of Carbaryl and Acephate in Reducing Damage by *Petrova metallica* (Busck) (Lepidoptera:Tortricidae) in Ponderosa Pine Windbreaks

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One late spring application of carbaryl, applied immediately after the end of moth flight, reduced the proportion of branches of ponderosa pine infested by *Petrova metallica* (Busck) in two of the four test years. One application of acephate did not reduce infestation levels.

Keywords: Insecticides, *Pinus ponderosa*, shelterbelts

Management Implications

Carbaryl may reduce infestations of *Petrova metallica* to an acceptable level if it is applied after the end of moth flight and before the young larvae mine into the tip. Because the timing of insecticide application varies with the year, moth flight must be closely monitored either through visual observations and/or with attractants.

Introduction

Ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) is commonly used in shelterbelt, Christmas tree, and urban landscape plantings in the northern Great Plains. Ponderosa pines frequently are infested by *Petrova metallica* (Busck), a shoot miner (Miller 1978). Larvae of *P. metallica* feed in and form pitch nodules on the growing shoots. While feeding, the larvae may destroy the terminal bud and one or more lateral buds. Pines of all size classes are vulnerable, especially those taller than 1.5 m (Van Deusen and Dix 1980). Heavily infested trees are severely stunted and deformed, reducing their effectiveness as protective field and farmstead plantings and their esthetic values.

P. metallica has a 1-year life cycle in the northern Great Plains. The moths emerge in May or early June, mate, and lay eggs on elongating shoots. Larvae feed within the growing shoots throughout the remainder of the growing season (Dix 1979).

Tree managers, landowners, and homeowners need methods for reducing *P. metallica* damage, that are safe for the environment and the applicator. Although several insecticides, including carbaryl and acephate, have been registered for control of related tortricid moths, such as *Rhyacionia* spp. (tip moths), none is registered for control of *P. metallica* (Hamel 1983). Therefore, this study evaluated carbaryl and acephate for their effectiveness in reducing damage by *P. metallica* in field windbreaks.

Methods and Materials

In early spring 1978 and 1979, 24 infested pines (12 pairs) in a north-south ponderosa pine windbreak, in Morton County, North Dakota, were selected for treatment. These previously untreated pines were 8–12 m tall and were spaced 3–4 m apart. Each pair was separated by a buffer zone of at least six infested pines.

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The pairs of pines were randomly assigned one of the following treatments: (1) acephate 75S (*O,S*-dimethyl N-acetylphosphoramidothioate)[2]; (2) carbaryl 80% WP (1-naphthylmethylcarbamate); and (3) no treatment (check). Treatments were replicated four times.

In 1978, carbaryl was applied at a concentration of 1.4 g (ai)/liter of water, and acephate was applied at a concentration of 0.6 g (ai)/liter of water. In 1979, the concentrations were 1.2 g (ai) carbaryl/liter and 0.9 g (ai) acephate/liter. A Spartan[2] hydraulic sprayer set at 150 psi was used to spray the crown of each tree to the point of drip run-off.

Because the windbreaks were too far away to check daily for moth emergence, timing of insecticide application (table 1) was based upon moth capture in sticky attractant traps and moth emergence from infested shoots collected in the windbreak. These infested shoots were kept in outdoor cages in Bottineau County, North Dakota. In 1978 trees were sprayed immediately after moth flight, while in 1979, cool May temperatures delayed moth flight until mid to late June, about 4 weeks later than in 1978. Thus, the trees were sprayed early in the moth flight.

In the 1978 and 1979 tests, the number of active *P. metallica*[3] nodules on the most east-facing branch of each whorl was counted in May before moth flight and insecticide treatment. Each fall after treatment and after the formation of visible pitch nodules, active nodules on the branches were counted.

In spring 1980, two north-south single-row ponderosa pine windbreaks infested with *P. metallica* were selected in Burleigh County, North Dakota. The trees were approximately 3 m apart and 4–7 m high in windbreak I and 3–6 m high in windbreak II. Thirty-six pines (12 plots of three adjacent trees) were selected for treatment in windbreak I. Six plots of four adjacent pines (24 pines) were selected in windbreak II. Test plots were separated by three infested pines.

[2]*The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others which may be suitable.*

[3]*The* Petrova metallica *were identified by William Miller, Department of Entomology, University of Minnesota, St. Paul.*

In 1981, 36 previously untreated pines (12 plots of three adjacent trees) were selected in windbreak I, and 18 previously untreated pines (six plots of three adjacent trees) were selected in windbreak II. Test plots were separated by three infested pines.

Treatments, as described for the 1979 test, were randomly assigned to the plots in each windbreak. Treatments were replicated four times in windbreak I and twice in windbreak II. The pines were hydraulically sprayed to the point of drip run-off in late May 1980 and in early June 1981. In 1980, the insecticides were applied during moth flight, and in 1981 immediately after moth flight.

In the 1980 and 1981 tests, the number of shoots infested with *P. metallica* on three east-facing branches and three west-facing branches of each tree were counted in May before moth flight, and in October after insecticide application.

The number of infested shoots per branch and proportion of branches infested were compared by analysis of variance using pairs (1978, 1979) or plots (1980, 1981) as the unit of replication. When appropriate, means were separated with Tukey's Multiple Comparison Test (Steel and Torrie 1960).

Results

Acephate did not significantly reduce the number of nodules in 1978, 1979, 1980, or 1981 (tables 1 and 2). Carbaryl was effective only in 1978 and 1981. In those two years carbaryl was applied immediately after moth emergence and flight (table 3). Carbaryl did not reduce the number of infestations when applied during moth flight.

Discussion

If greater control than that provided by carbaryl is desired, more toxic insecticides must be screened. Also, timing of insecticide application appears to be critical. The most effective time was after the termination of moth flight. Insecticides applied early in moth flight or during peak flight were ineffective probably because the larvae hatched when insecticide residuals were low.

Table 1.—Effect of acephate and carbaryl on infestations of *Petrova metallica* in a ponderosa pine windbreak, in Morton County, North Dakota.

Year	Treatment (8 trees each)	Infestations per branch		Proportion of branches infested	
		Pre[1] ($\bar{x}$ ± SD)	Post[1] ($\bar{x}$ ± SD)	Pre[1] ($\bar{x}$ ± SD)	Post[1] ($\bar{x}$ ± SD)
1978	Acephate	2.9b ± 1.41	1.6a ± 0.65	0.7a ± 0.12	0.7a ± 0.13
	Carbaryl	4.0a ± 1.61	0.6b ± 0.27	0.6a ± 0.14	0.3b ± 0.13
	Untreated	3.9a ± 2.04	2.1a ± 1.09	0.7a ± 0.20	0.7a ± 0.19
1979	Acephate	2.2a ± 1.10	0.6a ± 0.42	0.7a ± 0.16	0.4a ± 0.19
	Carbaryl	1.8a ± 0.86	0.8a ± 0.59	0.7a ± 0.12	0.4a ± 0.17
	Untreated	2.5a ± 0.88	1.0a ± 0.66	0.7a ± 0.15	0.5a ± 0.24

[1]*Column means for each year, which are followed by different letters, varied significantly (P<0.05) according to Tukey's Multiple Comparison Test.*

Table 2.—Effect of acephate and carbaryl on infestations of *Petrova metallica* in two ponderosa pine windbreaks, in Burleigh County, North Dakota.

Year	Treatment	Number of trees	Infestations per branch		Proportion of branches infested	
			Pre[1] ($\bar{x}$ ± SD)	Post[1] ($\bar{x}$ ± SD)	Pre[1] ($\bar{x}$ ± SD)	Post[1] ($\bar{x}$ ± SD)
1980	Acephate	20	1.1a ± 0.72	0.2a ± 0.31	0.5a ± 0.19	0.2a ± 0.18
	Carbaryl	19	0.8a ± 0.71	0.2a ± 0.31	0.5a ± 0.30	0.2a ± 0.21
	Untreated	20	1.0a ± 0.64	0.5a ± 0.47	0.4a ± 0.18	0.3a ± 0.22
1981	Acephate	16	0.2a ± 0.24	0.1a ± 0.19	0.2a ± 0.18	0.10a ± 0.120
	Carbaryl	17	0.5a ± 0.43	0.1a ± 0.19	0.3a ± 0.23	0.08b ± 0.136
	Untreated	16	0.5a ± 0.54	0.4a ± 0.28	0.3a ± 0.18	0.27a ± 0.181

[1]*Column means for each year, which are followed by different letters, varied significantly (P<0.10) according to Tukey's Multiple Comparison Test.*

Table 3.—Relationship of flight period to date of treatment with acephate and carbaryl.

Year	Flight period	Date of treatment
1978	May 22 - June 7	June 7
1979	June 11 - 24	June 15
1980	May 22 - 29	May 23
1981	May 22 - June 1	June 2

In each of the four years, the number of infestations in both treated and untreated plots decreased between the pretreatment count and posttreatment count. There is no clear-cut explanation for this decrease. It may have been the result of an increase in the number of parasites within the windbreak, a side effect of spraying in the windbreak, adverse environmental factors, or a combination of these.

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